

CLAIMS

What is claimed is:

1. An electrolyte membrane-electrode assembly for a fuel cell, comprising a polymer electrolyte membrane and a pair of electrodes, said polymer electrolyte membrane being interposed between said pair of electrodes, wherein:

each of said electrodes comprises a catalyst layer in contact with said polymer electrolyte membrane and a gas diffusion layer which has a water repellent layer in contact with the catalyst layer,

a base material of said gas diffusion layer is made of an electron conductive carbon fiber woven fabric, comprising a weave of a warp comprising electron conductive carbon fiber and a weft comprising electron conductive carbon fiber, and

an opening is formed adjacent crossing points of said warp and said weft.

2. The electrolyte membrane-electrode assembly for fuel cells in accordance with claim 1, wherein the relationship about $1/1500 \leq (10/W-Y)(10/Z-X)/XY \leq \text{about } 1/5$ is satisfied, where said carbon fiber woven fabric has a warp density of Z threads/cm, a weft density of W threads/cm, a warp thickness of X mm and a weft thickness of Y mm.

3. The electrolyte membrane-electrode assembly for fuel cells in accordance with claim 1, wherein said carbon fiber woven fabric has a thickness in a range of about 0.05 mm to about 0.3 mm.

4. The electrolyte membrane-electrode assembly for fuel cells in accordance with claim 1, wherein said carbon fiber woven fabric has a density in a range of about 0.32 g/cc to about 0.42 g/cc.

5. The electrolyte membrane-electrode assembly for fuel cells in accordance with claim 1, wherein one of a warp density and a weft density of said carbon fiber woven fabric is in a range of about 16 threads/cm to about 45 threads/cm, and the other of said warp density and said weft density is in a range of about 12 threads/cm to about 40 threads/cm.

6. The electrolyte membrane-electrode assembly for fuel cells in accordance with claim 2, wherein said carbon fiber woven fabric has a thickness in a range of about 0.05 mm to about 0.3 mm.

7. The electrolyte membrane-electrode assembly for fuel cells in accordance with claim 2, wherein said carbon fiber woven fabric has a density in a range of about 0.32 g/cc to about 0.42 g/cc.

8. The electrolyte membrane-electrode assembly for fuel cells in accordance with claim 2, wherein one of said warp density and said weft density of said carbon fiber woven fabric is in a range of about 16 threads/cm to about 45 threads/cm, and the other of said warp density and said weft density is in a range of about 12 threads/cm to about 40 threads/cm.

9. The electrolyte membrane-electrode assembly for fuel cells in accordance with claim 3, wherein said carbon fiber woven fabric has a density in a range of about 0.32 g/cc to about 0.42 g/cc.

10. The electrolyte membrane-electrode assembly for fuel cells in accordance with claim 3, wherein one of a warp density and a weft density of said carbon fiber woven fabric is in a range of about 16 threads/cm to about 45 threads/cm, and the other of said warp density and said weft density is in a range of about 12 threads/cm to about 40 threads/cm.

11. The electrolyte membrane-electrode assembly for fuel cells in accordance with claim 4, wherein one of a warp density and a weft density of said carbon fiber woven fabric is in a range of about 16 threads/cm to about 45 threads/cm, and the other of said warp

density and said weft density is in a range of about 12 threads/cm to about 40 threads/cm.

12. The electrolyte membrane-electrode assembly for fuel cells in accordance with claim 11, wherein said carbon fiber woven fabric has a thickness in a range of about 0.05 mm to about 0.3 mm.

13. A fuel cell electrode comprising:
a polymer electrolyte membrane;
a catalyst layer in contact with said polymer electrolyte membrane; and

a gas diffusion layer which has a water repellent layer in contact with the catalyst layer, wherein:

a base material of said gas diffusion layer is made of an electron conductive carbon fiber woven fabric, comprising a weave of a warp comprising electron conductive carbon fiber and a weft comprising electron conductive carbon fiber, and

an opening is formed adjacent crossing points of said warp and said weft.

14. The fuel cell electrode of claim 13, wherein

the relationship about $1/1500 \leq (10/W-Y)(10/Z-X)/XY \leq$ about $1/5$ is satisfied where said carbon fiber woven fabric has a warp density of Z threads/cm, a weft density of W threads/cm, a warp thickness of X mm and a weft thickness of Y mm.

15. The fuel cell electrode of claim 13, wherein said fabric has a thickness in a range of about 0.05 mm to about 0.3 mm.

16. The fuel cell electrode of claim 13, wherein said fabric has a density in a range of about 0.32 g/cc to about 0.42 g/cc.

17. The fuel cell electrode of claim 13, wherein one of said warp density and said weft density of said carbon fiber woven fabric is in a range of about 16 threads/cm to about 45 threads/cm, and the other of said warp density and said weft density is in a range of about 12 threads/cm to about 40 threads/cm.

18. The fuel cell electrode of claim 14, wherein said carbon fiber woven fabric has a thickness in a range of about 0.05 mm to about 0.3 mm.

19. The fuel cell electrode of claim 14, wherein said fabric has a density in a range of about 0.32 g/cc to about 0.42 g/cc.

20. The fuel cell electrode of claim 14, wherein one of said warp density and said weft density of said carbon fiber woven fabric is in a range of about 16 threads/cm to about 45 threads/cm, and the other of said warp density and said weft density is in a range of about 12 threads/cm to about 40 threads/cm.

21. The fuel cell electrode of claim 15, wherein said carbon fiber woven fabric has a density in a range of about 0.32 g/cc to about 0.42 g/cc.

22. The fuel cell electrode of claim 15, wherein one of a warp density and a weft density of said carbon fiber woven fabric is in a range of about 16 threads/cm to about 45 threads/cm, and the other of said warp density and said weft density is in a range of about 12 threads/cm to about 40 threads/cm.

23. The fuel cell electrode of claim 16, wherein one of a warp density and a weft density of said carbon fiber woven fabric is in a range of about 16 threads/cm to about 45 threads/cm, and the other of said warp density and said weft density is in a range of about 12 threads/cm to about 40 threads/cm.

24. The fuel cell electrode of claim 23, wherein said carbon fiber woven fabric has a thickness in a range of about 0.05 mm to about 0.3 mm.

25. A gas diffusion layer for a fuel cell electrode, said gas diffusion layer comprising:

a gas diffusion layer which has a water repellent layer for contacting with a catalyst layer of said electrode, wherein:

a base material of said gas diffusion layer is made of an electron conductive carbon fiber woven fabric, comprising a weave of a warp comprising electron conductive carbon fiber and a weft comprising electron conductive carbon fiber, and

an opening is formed adjacent crossing points of said warp and said weft.

26. The gas diffusion layer of claim 25, wherein the relationship about $1/1500 \leq (10/W-Y)(10/Z-X)/XY \leq$ about 1/5 is satisfied where said carbon fiber woven fabric has a warp density of Z threads/cm, a weft density of W threads/cm, a warp thickness of X mm and a weft thickness of Y mm.

27. The gas diffusion layer of claim 25, wherein said fabric has a thickness in a range of about 0.05 mm to about 0.3 mm.

28. The gas diffusion layer of claim 25, wherein said fabric has a density in a range of about 0.32 g/cc to about 0.42 g/cc.

29. The gas diffusion layer of claim 25, wherein one of said warp density and said weft density of said carbon fiber woven fabric is in a range of about 16 threads/cm to about 45 threads/cm, and the other of said warp density and said weft density is in a range of about 12 threads/cm to about 40 threads/cm.

30. The gas diffusion layer of claim 26, wherein said carbon fiber woven fabric has a thickness in a range of about 0.05 mm to about 0.3 mm.

31. The gas diffusion layer of claim 26, wherein said fabric has a density in a range of about 0.32 g/cc to about 0.42 g/cc.

32. The gas diffusion layer of claim 26, wherein one of said warp density and said weft density of said carbon fiber woven fabric is in a range of about 16 threads/cm to about 45 threads/cm, and the other of said warp density and said weft density is in a range of about 12 threads/cm to about 40 threads/cm.

33. The gas diffusion layer of claim 27, wherein said carbon fiber woven fabric has a density in a range of about 0.32 g/cc to about 0.42 g/cc.

34. The gas diffusion layer of claim 27, wherein one of a warp density and a weft density of said carbon fiber woven fabric is in a range of about 16 threads/cm to about 45 threads/cm, and the other of said warp density and said weft density is in a range of about 12 threads/cm to about 40 threads/cm.

35. The gas diffusion layer of claim 28, wherein one of a warp density and a weft density of said carbon fiber woven fabric is in a range of about 16 threads/cm to about 45 threads/cm, and the other of said warp density and said weft density is in a range of about 12 threads/cm to about 40 threads/cm.

36. The gas diffusion layer of claim 35, wherein said carbon fiber woven fabric has a thickness in a range of about 0.05 mm to about 0.3 mm.

37. An operation method of a fuel cell having an electrolyte membrane-electrode assembly which comprises a polymer electrolyte membrane and a pair of electrodes, said polymer electrolyte membrane

being interposed between said pair of electrodes, wherein each of said electrodes comprises a catalyst layer in contact with said polymer electrolyte membrane and a gas diffusion layer which has a water repellent layer in contact with the catalyst layer, a base material of said gas diffusion layer is made of an electron conductive carbon fiber woven fabric, comprising a weave of a warp comprising electron conductive carbon fiber and a weft comprising electron conductive carbon fiber, and an opening is formed adjacent crossing points of said warp and said weft, said method comprising:

generating electric power by providing a supply of a humidified fuel gas to an anode electrode of said pair of electrodes and a supply of a humidified oxidant gas to a cathode electrode of said pair of electrodes;

controlling the dew point of said fuel gas to a temperature equivalent to, or 5°C or less lower than, the temperature of said electrolyte membrane-electrode assembly in operation; and

controlling the dew point of said oxidant gas to a temperature equivalent to, or 5°C or less lower than, the temperature of said electrolyte membrane-electrode assembly in operation.